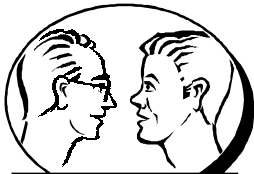


Rapport nr. 007/15  
**FISH WASTE IN JAPAN**



GENERELT

## RAPPORT-TITTEL

# THE UTILIZATION OF FISH WASTE IN JAPAN

RAPPORTNUMMER	007/15	PROSJEKTNUMMER	007
UTGIVER	RUBIN	DATO	Jun. 1993

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### SAMMENDRAG OG KONKLUSJONER

Hensikten med prosjektet er å få en oversikt over biproduksituasjonen i Japan. Rapporten viser hvilke mengder av fisk og sjømat som ble fangstet og produsert i 1991. Den gir en oversikt over hvor mye biprodukter som oppstod og hvor mye som ble utnyttet. Rapporten gir også en oversikt over hva som produseres av den delen som ble utnyttet. Tallene nedenfor er angitt i tonn og gjelder for 1991.

	Produksjon	Biprodukter	Forbrenning	Utnyttet
Fiskeri	7.900.000	4.700.000	4.100.000 <sup>1)</sup>	175.000 (mel, olje)
Oppdrett	265.000	160.000		
Skjell	779.000	646.000	0	646.000 (kalking, mm)
Sum	8.944.000	5.506.000	4.100.000	821.000

<sup>1)</sup> Inkl. biprodukter fra oppdrett

Japan fangster ca. 10 ganger så mye fisk som Norge. Mesteparten fangstes av små fartøyer som er organisert i små lokale organisasjoner. Organisasjonene selger det meste av fisken videre til lokale butikker og japanske hjem. Biproduktene blandes med annet kjøkkenavfall og leveres til kommunale forbrenningsanlegg. Dette utgjør ca. 85 % av den totale mengden med biprodukter.

Industri, supermarked og restauranter må selv sørge for å bli kvitt biproduktene sine. Biproduktene samles inn og går i hovedsak til produksjon av fiskemel og olje. Innsamlingen må "produsenten" av biprodukter betale for til spesielle innsamlingselskaper. Biproduktene samles inn ferske, og hverken frysing eller ensilering blir brukt som metode. Store fiskeribedrifter har omtrent stoppet fiske på pelagiske arter, og importerer i stedet frossen fisk og andre sjøprodukter til videreforedling.

I tillegg til fiskeolje og fiskemel produseres det en del spesialprodukter som feks. EPA-produkter (eicosapentaenoic acid), DRA (dicosahexaenoic acid), taurine og kitosan.

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## 1.0 OVERVIEW

Japan is a marine nation as well as Norway. Her total production in fisheries reaches to 9.870 Tt in 1991, which includes fish 7.028 Tt, other marine products 861 Tt, clams and shells 350 Tt, fanned fish 265 Tt, farmed shellfish 429 Tt, and fanned seaweeds 567 Tt (see Fig. 1). The amount has decreased year by year since 1988 when the peak fish catch of 12.000 Tt was recorded, because of the 200 miles territorial water regulations enforced among many countries. The decrease has been eminent in salmon, herring, crab fishing on the North Pacific Ocean, as well as in offshore fishing of sardine and mackerel. The production from fish farming has been stable in the last few years.

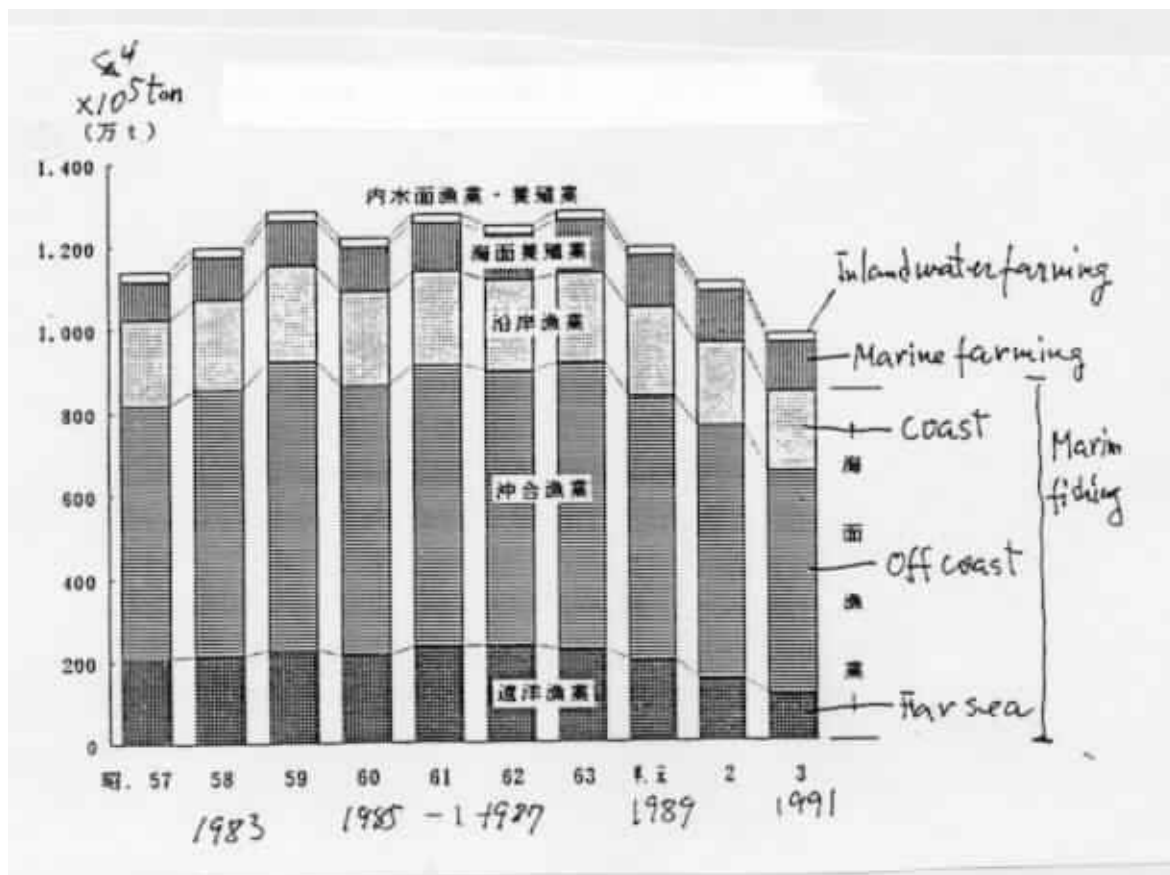


Fig. 1 Fisheries in Japan

The majority of fishing organizations are small individual fishermen as well as small and medium sized fishery companies. Local fishermen's cooperative associations take care sales of caught fish and other marine products, buying necessities for fishermen, and construction of port facilities, as well as treatment of fish wastes. The total number of fishing organizations has been also decreasing by nearly 3% yearly in the last few years. Large fishery companies over the capital of ¥1 billion (i.e. NOK 50 million) have almost stopped their own pelagic fishing operations.

At present, revenue from fishing operations accounts for only around 4% of their total turnover. Their main business today are the import of frozen fish, fresh fish and other food products, as well as the production of various processed food products. Therefore, the production of fish meal and other products onboard large fishing vessels which are operated by large fishery companies has come much smaller than it used to be, along with the diminishing the arbitrary dumping of fish waste into the sea.

Majority of caught fish (and other marine species) are treated in small fish shops or at home in Japan. Fish wastes generated in those places are collected mixedly with other city waste by public service run by cities, towns, or villages, to be brought to big furnaces constructed by local authorities of the said level. Such treatment is required by the Waste Treatment Law. The Ministry of Health and Welfare provides financial support for the construction of such furnaces.

Fish wastes are generated also by food industries, supermarkets and restaurants etc. The Waste Treatment Law requires proper treatment for the fish wastes from those places at their own expense. The gutting wastes produced from those places are partly processed by themselves and partly collected by producers of fish waste meal and oil. When collecting the waste, those who produce the waste pay ¥3,500-5,000 (i.e. NOK 175~250) per month to the collectors, i.e. fish waste meal and oil producers. In both cases, the said law has been efficiently practised, which has contributed greatly for the improvement of environment in Japan for the last couple of decades.

In total, around 4,860 Tt of fish wastes are generated annually in Japan excluding wastes from shellfish, of which majority (ca. 85%) go to city wastes, ca. 700 Tt (i.e. 14%) are utilized for the production of fish waste meal and oil, and some unspecified minor quantity are utilized for the production of other valuable projects mentioned as follows. In most cases, production of the two products takes place in the same production facilities.

Out of ca. 700 Tt of fish wastes as raw material, ca. 140 Tt of fish waste meal and ca. 35 Tt of fish waste oil are produced. The selling price of fish waste meal is reportedly ca. ¥60,000/ton (i.e. NOK 3,000/ton), which total value accounts for ¥8,4 billion (i.e. NOK 420 million). The total amount of fish oil production in 1991 was 315 Tt, of which 280 Tt is sardine oil produced from whole sardine fish. Therefore, the amount of fish waste oil is estimated to be 35 Tt. Fish oil is mainly used for the production of margarine, soap or higher alcohols. Besides, it is partly consumed as fuel within the fish oil production plants. Major producers of fish waste meal and fish waste oil include Taiyo Gyogyo Co. (1-1-2 Otemachi, Chuo-ku, Tokyo) and Sanki Shiryo Co. (1 126 Matsui, Soka-shi, Saitama pref.).

Summarizing the above, the current production of fish waste meal and fish waste oil are shown in Table 1.

	Production (Tt/year)	Total Value (million ¥)	Unit Price (¥ per ton)
Fish waste meal	140	8,400	ca.60,000
Fish waste oil	35	1,700	ca.50,000

**Table 1** Production of Fish Waste Meal and Fish Waste Oil in Japan (as of 1991)

The noteworthy products from fish oil include EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid). Nippon Suisan Kaisha, Ltd. (2-6-2 Otemachi, Chiyoda-ku, Tokyo) is an only producer of EPA ethylene in pure form (usually referred to as EPA-E). Such companies as Kanematsu Shokuhin Co. (3-13-3 Tsukiji, Chuo-ku, Tokyo) and Taiyo Gyogyo Co. produce both EPA-rich oil and DHA-rich oil. DHA is effective to improve the activity of brain, nerve and remembrance, as well as effective against allergy and so on. DHA is sold as medicine, or an additive to powdered milk and canned foods. Major powdered milk producers which utilize DHA-rich oil include Meiji Milk Co. (2-3-6 Kyobashi, Chuo-ku, Tokyo).

Taurine, a kind of sulphur containing amino acid, is another valuable product extracted from fish wastes. It is produced from the boiled water of crabs, squids, octopus or shellfish. A major producer of Taurine is Nippon Suisan Kaisha, Ltd. This amino acid is effective for health in general, and for eye and liver in particular. It is assorted in vitamin tablets and powdered milk for babies, etc.

Chitosan is another noteworthy product from such fish wastes as shell of crab and lobster. It is mainly used as an agent to condense and dehydrate activated sludge in industrial and public waste water treatment. Purified-form chitosan is also used for such medical applications as biodegradable threads and artificial skins for surgical operations. In the whole world, 500 ton of Chitosan is produced annually, of which Japan produces 300 ton. The leading producer of chitosan in Japan is Kyowa Technos Co., Ltd. (2759-3, Koike, Shibayama-cho, Yamatonegun, Chiba pref. 289-16).

The current production of these special products which can be produced from fish waste are shown in Fig.3. At present, these products are partly made from fish waste.

	Production (ton/year)	Total value (million ¥)	Unit Price (¥ pr g)
EPA-E	20	30.000	1.500
EPA-rich oil	10	2.000	200
DFIA-rich oil	20	10.000	500
Taurine	7-10	10.000 <sup>1)</sup>	1.000-1.400 <sup>1)</sup>
Chitosan	300	600	2

1) For rough estimation only

**Table 2** Production of special products from Fish Waste in Japan

Surimi, a shredded and frozen white fish meat is a big marine product in Japan. In 1991 its production reached to 201 Tt. It is made mainly from Alaska pollack and some from other white meat fish. This is not a fish waste, but it is worth to note as a special marine product in Japan. Surimi is mixed with a small amount of starch, vegetables and others, steamed or fried in various types including fish sausage and fish ham (78 Tt). These are popular sea foods in Japan.

All in all, a schematic flow of fish waste is shown in Fig. 2.

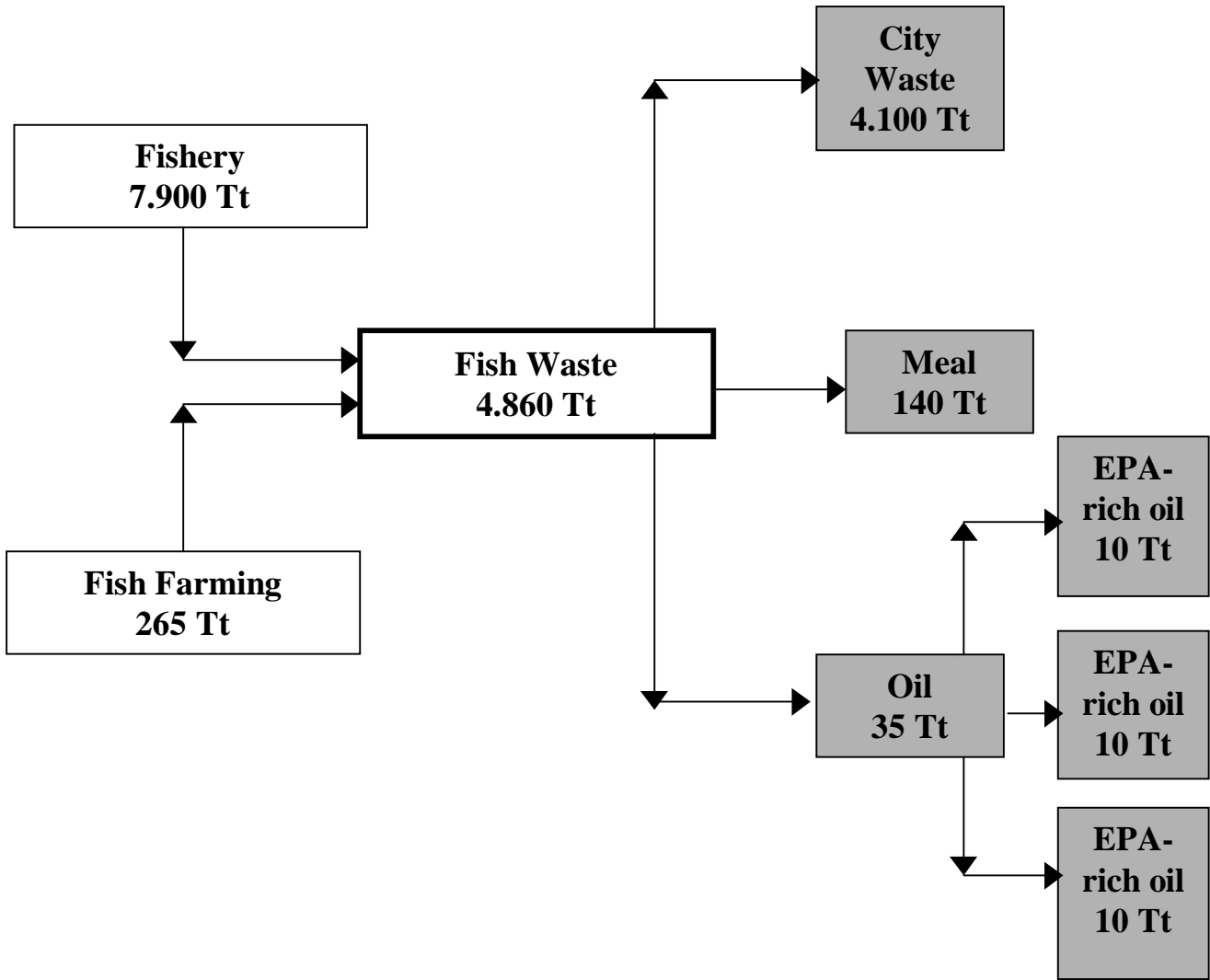


Fig. 2 Schematic Flow of Fish Waste (part 1)

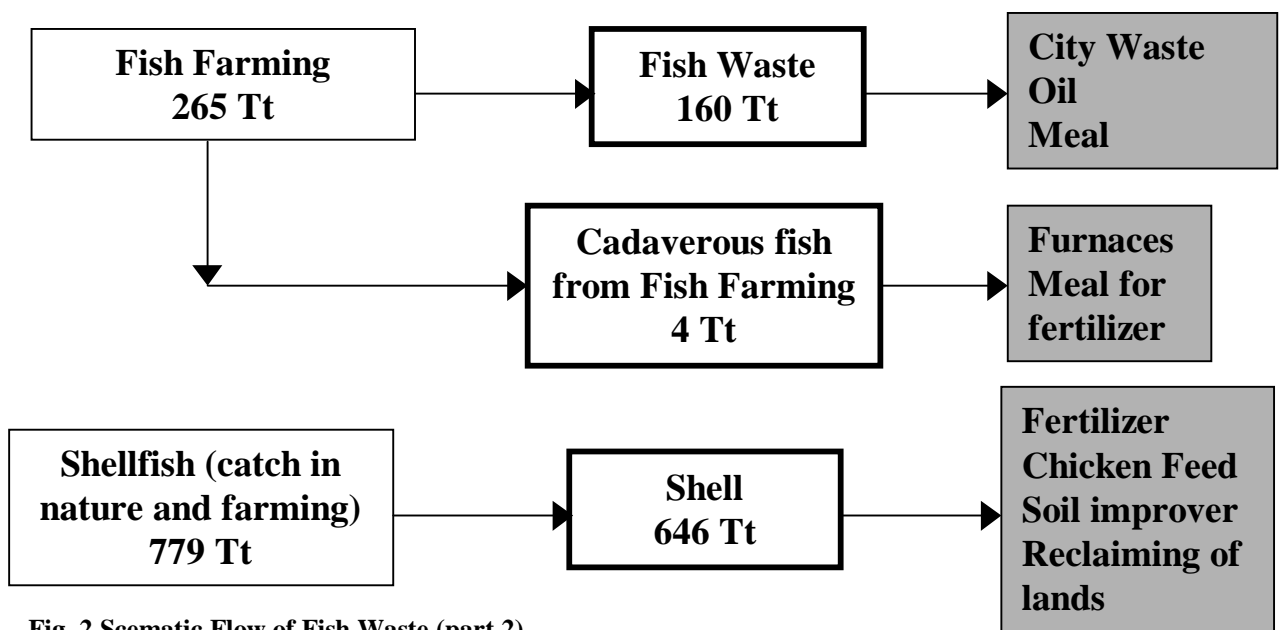


Fig. 2 Schematic Flow of Fish Waste (part 2)

## 2.0 QUANTITIES - 1991

### 2.1 MARINE FISHERY

	Species	Tons in 1991 (x 1.000)
Marine fishery	Tuna	281
	Bonito	395
	Salmon	193
	Alaska pollack	554
	Sardine	3.334
	Horse mackerel	221
	Mackerel	251
	Saury pike	300
	Yellow tail	51
	Flat cod	66
	Cod	49
	Others	1.333
Marine products other than fish	Lobster	1
	Tiger shrimp	3
	Other shrimp	38
	Squids	528
	Seaweeds	98
	others	193
Fishery Grand Total		7.889

**Table 3** Caught Fish and other Marine Products in 1991

Fish Waste from Fishery (Grand Total x ca.60%)	4.700
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**Table 4** Fish Waste from Fishery in 1991

Onboard fish processing plants have almost ceased to operate. Fishes caught in far sea by large fishing vessels are usually frozen onboard and brought to the processing plants on land to be processed. Exceptionally, south bound trawling to catch merluza, hoki, sea perch and ring cod are operated to fillet or gut onboard, and the generated wastes are dumped into sea.



The amount of such waste is estimated to be around 50 Tt ~ 1 00 Tt or less, based on the total catch of south bound trawls to be around 170 Tt. Tuna caught on far sea are also processed onboard where the guts are dumped. Its amount is estimated to be around 1 0 Tt - 30 Tt.

In total, onboard dumping of marine fish waste is estimated to be around 60 Tt - 130 Tt, which is equivalent to 1,3 - 2,7% of the total fish waste generated from fishery, i.e. 4.700 Tt. There is no statistical data available on this as far as our knowledge is concerned.

Most of fish captured in coast or off-coast water are stored in onboard water tanks and brought to fishing ports within the same day. Such round fish (inclusive head and guts) are stored with crashed ice and transported to fish markets. Some expensive fish are transported to fish markets even alive in sea water tanks cooled and bubbled with oxygen.

Smaller fish shops buy round fish from fish markets, and usually remove head and guts to fillet or just to truncated forms at the shops on customers' request. For example, smaller fish like hoarse mackerel and saury pike are gutted only at fish shops, and cooked at home. Or, smaller fish are often cooked at home as well with head, tail, and bone on. For example, roasted or cooked head of red sea bream is regarded as a delicacy. As stated in page 2 of the report, fish waste from smaller fish shops and household account for about 85% of the total fish waste of 4.860 Tt., which go to city waste.

Fish waste from supermarkets and bigger fish shops go to fish meal factories. The total amount of fish waste processed at fish meal factories is 700 Tt., which accounts for around 14% of the total fish waste of 4.860 Tt.

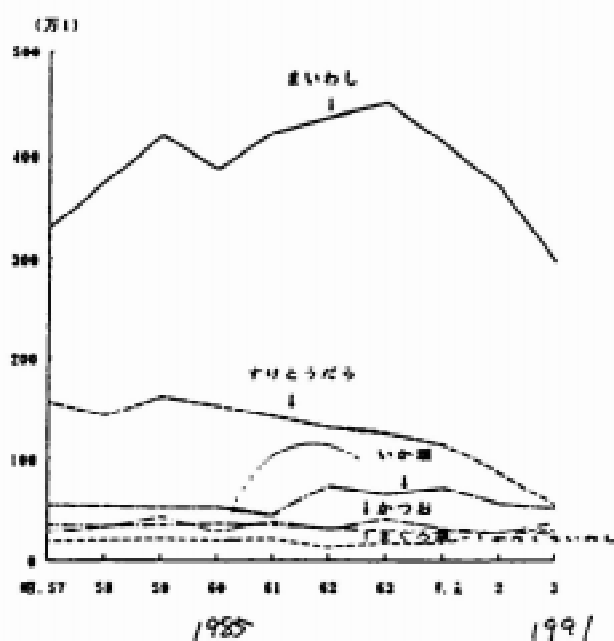


Fig. 3 Production in marine fishery in 1991

## 2.2 FISH FARMING

Species	Tons in 1991 (x 1.000)
Yellow tail	162
Red sea bream	57
Silver salmon	24
Shrimp	2
Others	18
Total	265

**Table 5** Production from Fish Farming in 1991

Fish Waste from Fishfarming (Total x ca.60%)	160
--	-----

**Table 6** Fish Waste from Fish Farming in 1991

Medicine is often used for fish farming in Japan under the guideline set by MAFF. Such medicines comprise oxytetracycline, sulfomonomethoxin, ampicilline, erythromycine, spiramycine, fluorophenicole, nalidixic acid and so on. The permitted amount of each medicine is indicated by species such as yellow tail, horse mackerel, and shrimp. Medication to farmed fish is required to be terminated before 40 days of shipment in most cases.

The amount of cadaverous fish from fish farms will probably cease from 3.700 tons in 1989 to 4.500 tons in 1995. The treatment of cadaverous fish is under the guideline issued by the Ministry of Health and Welfare. They are usually burnt or processed to fish meal for fertilizer by small factories. This kind of meal (selling price: ¥40/kg) is not mixed with other meals. These factories are not profitable, but supported by fish farmers. For the construction of these small burning and meal factories, the cities, towns or villages give financial support to cover half of their expenses, with low-interest financing from the Ministry of Health and Welfare. In case of accidental fish death by toxic plankton or some other causes, some amount of cadaverous fish are directly used for manure or buried in the soil. But the amount is not so big.

## 2.3 SHELLFISH

	Species	Tons in 1991 (x 1.000)
Catch in nature	Abalone	3
	Top shell	8
	Little clam	67
	Scallop	179
	Others	1
Farmed	Scallop	189
	Oyster	239
	Others	1
	Total	779

**Table 7** Caught and Farmed Shellfish in 1991

Waste from Shellfish (total x ca. 83%)	646
--	-----

**Table 8** Waste form Shellfish in 1991

Most of waste shells are destructed in rough powder for mixing to fertilizer and to chicken or animal feeds. Spraying of the rough power onto soil fosters neutralization of acidic soil. Some part of waste shells are used for the reclaiming of lands.

## 2.4 FARMED SEAWEEDS

Species	Tons in 1991 (x 1.000)
Laminarians	54
Undaria (Wakaine)	112
Porphra	387
Others	14
Total	567

**Table 8** Farmed Seaweeds in 1991

Waste are almost none.

## 2.5 FISH WASTES IN TOTAL (ESTIMATED)

	Tons in 1991 (x 1.000)
Fishery	4.700
Fish farming	160
Cadaverous fish from fish farming	4
Shellfish catch in nature	290
Farmed shellfish	356
Farmed Seaweeds	0
Total	5.510

**Table 9** Fish Waste in total in 1991

### 3.0 ORGANIZATIONS

#### 3.1 NUMBER OF FISHING AND FISH FARMING ORGANIZATIONS (AS OF 1991)

The total number of fishing and fish farming organizations are 179.529. The number shows 2,5-2,9% yearly decrease within the last several years continuously. This is caused by the gutting of small fishing business by younger people. The majority of these organizations are individual fishermen.

Individual fishermen	170.253
Small and medium sized fishery companies	9.069
Large fishery companies	207
Total	179.529

**Table 10** Number of Fishing and Fish Farming Organizations in 1991

### 3.2 NUMBER OF FISH FARMING ORGANIZATIONS (AS OF 1990)

	Species	Production (Tt)	No.of organizations
Fish	Yellow tail	161	2.585
	Red sea bream	52	2.871
	Horse mackerel	6	429
	Other fish	37	2.231
Other marine animals	Shrimps	2.6	160
	Ascidians	7.2	1.190
	Other marine animals	0,035	82
Shellfish	Scallop	192	6.571
	Oyster	249	4.822
	Other shellfish	1.5	551
Seaweeds	Lamiarians	54	4.296
	Undaria (Wakame)	113	11.079
	Porphra	387	14.215
	Other seaweeds	11	502
	Pearl shellfish	70	2.112
Total		1,273	53.696

**Table 11** Number of Fishing and Fish Fanning Organizations in 1990

### 3.3 NUMBER OF FISHING VESSELS (AS OF 1991)

Type of Vessels	Breakdown	No.
With no engine		11.432
With out board motor		104.143
With engine	less than 1 ton	12.533
	1-3	57.758
	3-5	56.668
	5-10	15.494
	10-20	9.324
	20-30	80
	30-50	423
	50-100	1.249
	100-200	1.102
	200-500	1.322
	500-1.000	3
	1.000-3.000	13
Over 3.000	11	
Total		271.559

**Table 12** Number of Fishing Vessels in 1991

### 3.4. LARGE FISHERY COMPANIES

The fishing amount of large fishery companies has decreased extensively due to the 200 miles territorial water regulations. Nowadays, their share among the total amount is only 4% or so. Instead, they import frozen and fresh fish, frozen meat, agricultural products, and other foods. They produce canned foods, fish meal, oil and fat, and other various food products. Some of them conduct marine transportation as part of their business.

### 3.5. STRUCTURE IN FISHING FLEET

Along with the change of large fishery companies, large fleets with mother ships and catcher boats have ceased to exist. The majority of fishing is conducted by single fishing vessel, including far sea troll fishing. Only ca. 0.5% of engined fishing vessels operate in small fishing fleets each of which consists of two or four vessels.

A fishing fleet for deep-sea troll fishing consisting of two fishing vessels. They catch 45 Tt of Alaska pollack, squid, cod and others.

Vessels	Fleets
< 50 ton	5
50 - 100 ton	65
> 100 ton	4
Total	74

**Table 13** Structure in the Fishing Fleet for Deep-Sea Troll Fishing

Vessels	Fleets
No engine	5
< 5 ton	18
5 - 10 ton	11
10 – 20 ton	75
Total	109

**Table 14** Structure in the Fishing Fleet for Coast Pursesein Fishing

A fishing fleet for coast pursesein fishing consisting of four or two fishing vessels. In today's fishing, a four fishing vessel group consists of one detector, two catchers, and one for the rapid transportation of caught fish to fishing ports where fish markets are located. They catch 1 / 5 Tt of sardine, hoarse mackerel, mackerel and others, in total.



## 4.0 CONSERVING FISH WASTE

Although transportation and long-term stock of frozen fish are commonly practiced in Japan, stock of fish waste by freezing or in big silos is not been practiced. Production of fish waste meal is not so profitable that it does not allow such costly procedures.

The ensilage of fish waste has not been performed in Japan. This is perhaps due to the fact that climate is warmer in Japan than in Norway. Further investigation is needed to find more about this.

## 5.0 MARKET FOR FISH WASTE

### 5.1 FISH MEAL

As described in Chapter I, the most common product from fish waste is fish waste meal. Its production in 1991 is 140 Tt. Its average price is ¥60.000/ton (i.e. NOK 3.000/ton) so that the total production in value is estimated to be ¥8,4 billion (i.e. NOK 420 million). These fish waste meal are mixed with whole fish meal which are mainly produced from sardine. There is no statistics for the usage of fish waste meal itself, however, there are data available for that of fish meal which includes both fish waste meal and whole fish meal:

Total production of fish meal	816 Tt/year
Total value	¥ 76 billion (i.e. NOK 3.8 billion)
Average price	¥ 93.000/ton (i.e. NOK 4.650/ton)
Usage of fish meal:	
feedstuff for fish farming	190 Tt
feedstuff for animal husbandry	482 Tt
fertilizer	104 Tt
other usage including pet food	40 Tt

In Japan, it is regarded that feed for fish farming should be the best grade. Fish waste meal is low grade fish meal, so that the usage of fish waste meal for feedstuff for fish farming is lower than that of whole fish meal. In contrary, fish waste meal is mostly mixed in fertilizer.

The total production of formulated feed for animal husbandry is 26.000 Tt in Japan, based on which the said feed is calculated to contain 1.85 % of fish meal in volume. In the meantime, the total value of the said feed is ca. ¥1 trillion (i.e. NOK 50 billion).

The total production of pet food (for dog, cat, birds, tropical fish, and so forth) is 410 Tt. Its total value is ¥ 230 million (i.e. NOK 11.5 million). The content of fish meal in pet food is

variable. For instance, dry cat food (total production is 71 Tt/year) contains 10-20% of fish meal.

The total production of formulated feed for fish farming is 355 Tt/year. The feed is sold at ¥ 140 - 210/kg to fish farmers. The content of fish meal in the feed is calculated to be ca. 54 %.

There are two types of companies which produce both fish waste meal and fish waste oil: One is large fishery companies which produce fish meal and oil from both whole fish and fish waste. Such companies utilize fish waste generated in their own fish processing plants. Taiyo Gyogyo Co. (1-1-2 Otemachi, Chiyoda-ku, Tokyo) is a typical company in this category.

Another is smaller companies specialized in the production of fish waste meal and oil. Such companies collect fish waste from fish shops in cities, from supermarkets, from restaurants and to produce fish waste meal and fish oil in their plants called "Arakasu (means fish waste) factories" in Japan. There are three Arakasu factories in Tokyo area, and other ten or more are in Nagoya, Osaka, Fukuoka and Japan's Inland Sea area. prefectures around Tokyo) and nearby districts, daily 400 ton of fresh fish waste from 13,000 shops in total. Sanki Shiro Kogyo Co. does not buy fish waste, but as a matter of fact, the company charges ¥3,500-5,000 per month to each of those places (i.e. fish shops, supermarkets, and restaurants) which generate fish waste.

Besides those two types of fish waste meal and oil producers, there are companies which produce fish meal and oil from whole sardine fish. They are located in Hokkaido area or near a certain fishing ports which often give excessive sardine catch. A representative company in this category is Kushiro High-Meal Co. (7-1-2 Tottori minami, Kushiro-shi, Hokkaido).

## **5.2 FISH OIL**

Fish oil is produced from fish waste along with the production of fish waste meal. Its total production is ca. 35 Tt/year. Its price is variable time to time, however, around ¥50,000/ton (i.e. NOK 2,500/ton). The estimated total value of fish waste oil is ¥1.750 billion (i.e. NOK 88 million). The total production of fish oil including the oil from whole sardine fish is ca. 315 Tt/year. The total value is around ¥16 billion (i.e. NOK 800 million).

Fish oil is mainly used for the production of margarine, as well as for the soap, higher alcohols and for fuels. The fish meal producers often burn their home-made oil in their factories.

## **5.3 PRICING MECHANISM**

Prices of fish waste meal and fish waste oil are determined without the public aid. However, the meal production from cadaverous fish generated from fish farming is totally different. This kind of meal is allowed to use for fertilizer only, and less expensive. Factories for such meal are much smaller, constructed with the financial aids by such public organizations as cities, prefectures, towns and so on, to the extent of half of the expenses. Moreover, the low interest financing is offered by the Ministry of Health and Welfare. These factories are operated usually by fishermen's cooperative associations of each district at the expense of fish farmers.

## **5.4 INTEGRATION INTO TRADITIONAL FISH MEAL PRODUCTION**

As described in Section 1 of this Chapter (see page 15), there are two types of fish waste meal producers in Japan, one of which, i.e. large fishery companies, produce both fish waste meal and whole fish meal by using the same production facilities. Fish waste meal is produced in the separate batches from whole fish meal. In final fish meal products, fish waste meal is often mixed with whole fish meal.

## 5.5 PUBLIC REGULATIONS

The Waste Treatment Law set by the Japanese government is effectively regulating the dumping of fish waste. This law is efficiently working in Japan in recent years, sometime with heavy punishment on relevant factories which are violating the regulations. It regulates both city wastes and industrial wastes. 30 years ago, pollution was heavy in Japan, but now Japan is considered to be a leading country on pollution control. The depriving sulphur oxide from factory smokes is commonly practiced in many large factories. Smokes are also regulated, along with the regulation of NOx and SOx from the exhaust of cars. As for fishing, fish are returning to rivers even in Tokyo city. In the Tokyo Bay, the purse-sein fishing by small fleets, each of which consists of four vessels, is catching sardine, mackerel, hoarse mackerel and other fish. Today, such fishes are sold at relatively high prices in the fish markets due to its superior freshness.

City wastes, including fish wastes from home and small shops are required to be collected by the cities, prefectures, towns and other public organizations, and to be burnt in big public furnaces. For the construction of such furnaces, the Ministry of Health and Welfare provides financial support.

Industrial fish wastes are required to be treated properly at the expense of industries. Further treatment to produce fish waste meals, to burn, or to clean with the activated sludge ponds are required.

## 5.6 PUBLIC FUNDING ARRANGEMENTS FOR THE RECYCLING OF FISH WASTE

As described formerly, there is no public support for the production of fish waste meal or fish waste oil. However, for the treatment of cadaverous fish from fish farms, and for the treatment of scallop and oyster shells from shellfish farms, cities, towns, or villages give financial support of half of the construction cost of the factories, as well as the low interest finance from the Ministry of Health and Welfare. Operational expenses of such small factories are shared among fish/shellfish farmers.

## 5.7 FUR FARMING IN JAPAN

Mink and silver fox have been farmed in the northern island of Japan called Hokkaido. The following is the domestic fur production from mink and silver fox as of 1992, compared to the import.

	Production	Import
Mink	300.000	260.000

Silver Fox	20.000	370.000
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**Table 15** Fur Farming in Japan in 1992

A head (of mink and silver fox) is said to consume about 40 kg of feeds per year, so that the total amount of feed consumption for fur farming is estimated to be about 13 Tt per year. Feed for fur farming include about 10% of fish meal. Therefore, the estimated fish meal consumption for fur fanning would be around 1.3 Tt annually, which accounts for less than 1% of the total fish meal production in Japan, i.e. 140 Tt. Production of fur fluctuates much by business conditions such as market price of fur. There are also other kinds of furs made from wild animals, but their production is not so large.

## **6.0 SPECIAL PRODUCTS FROM FISHWASTE**

### **6.1 EPA (EICOSAPENTAENOIC ACID)**

EPA is produced, for instance, from sardine oil which contains EPA as well as DHA in some degree. Sardine oil is concentrated to rich oil containing EPA 25% and DHA 15% through alkali treatment, decolorization with carbon, with active white soil and with wintering. This, so called, EPA-rich oil (which also contains DHA) is capsulated for oral administration or directly assorted to canned foods, powdered milk and others.

Producers of EPA-rich oil often produce DHA-rich oil from other raw materials as well, as described in Chapter 1. EPA-rich oil is effective against arteriosclerosis and for improving the fatty acid quality in blood. Reportedly, production of EPA-rich oil is around 10 ton/year in recent years, which total value would be around ¥2 billion (i.e. NOK 1 00 million).

The purer form of over 90% EPA ethylester (EPA-E) is produced only by Nippon Suisan Kaisha, Ltd. EPA rich sardine oil is converted to ethylester. Then, through fine distillation separation under high vacuum and through area treatment, the industrial process was established. This process is patented. They are producing 17-20 ton/year of EPA-E, which value is estimated to worth ¥17 billion (i.e. NOK 850 million). EPA-E is exported to USA and some other countries. Mochida Pharmaceutical Co. (1 - 1 - 1 Kamiya, Kita-ku, Tokyo 115) has the right to sell the product. They are expecting its market will increase to ¥30 billion (i.e. NOK 1.500 million) in its use against brain stroke and arteriosclerosis. EPA is known to be non-toxic, mild and natural.

### **6.2 DHA (DOCOSAHEXAENOIC ACID)**

DHA is produced from the eye fat of tuna fish which contains DHA 27% and EPA 7%. Production of DHA-rich oil is 20 ton/year, which is worth ca. ¥10 billion (i.e. NOK 500 million). About 10 ton/year of DHA-rich oil is used for assorting to powdered milk and canned food etc., and the rest in the capsule for the oral administration. DHA is the general ingredient in human brain and nerve. It is believed to be effective for the health of brain and nerve, and for remembrance.

More than ten companies are endeavoring for the extensive research to its use and for its purification process. DHA is a natural product as EPA and non-toxic. They are expecting the broadening of its use more than EPA.

DHA is produced by Kanematsu Shokuhin Co., Taiyo Gyogyo Co., Nihon Yushi Co. (4-1 0-1 Toshima, Kita-ku, Tokyo) and Nippon Suisan Kaisha, Ltd.

### **6.3 TAURINE**

Natural form of taurine is produced by Nippon Suisan Kaisha, Ltd. from the boiled extracts of crab, octopus, squid and shellfish. It is a natural product and allowed to assort to many foods including powdered milk for babies. Its total annual production is around 7-10 ton. The synthetic taurine is produced by many pharmaceutical companies. It is an usual component of multi-vitamin tablets, anti-crapulence, and for the health of eye and liver. This amino acid is

present in human milk but not in cow's milk. It depresses the cholesterol content in human blood.

## **6.4 CHITOSAN**

The shell of crab, lobster, insects are constituted by chitin which is one of the abundant natural product. For instance, crab shell contains 40% calcium, 30% protein, and 30% chitin. Crab shell is the main waste from factories to produce canned crab meat in Japan. Through the treatments with dilute HCl and dilute alkali, chitin is obtained, which is not soluble in water. With further hydrolysing with heavy alkaline solution, chitosan is obtained which is water soluble, natural cation-exchanger of polymer type. Its monomer unit is 2-amino-2-deoxy D-glucose. The molecular weight of the polymer is around 200,000.

Chitosan is developed in Japan as condensing polymers. Its use is in 90% for the condensing agent to waste water from factories, for the condensation and dehydration of activated sludge in order to diminish its burning charge. The resulted precipitant is partly used as natural fertilizers. Chitosan is used also for the filter-aids and for precipitating agents of proteins and others in food factories and pharmaceutical factories.

Threads made of purified chitosan are used for the treatment of human operation, and films made of purified chitosan are used for covering burnt wounds.

The annual production of chitosan in Japan is ca. 300 ton (¥2,000/kg, ¥600 million totally). In the whole world, its production is ca. 500 ton in total (¥4,000-7,000/kg in the U.S. for instance).

The main producer of chitosan is Kyowa Technos Co., Ltd. (2759-3, Koike, Shibayama-cho, Yamatake-gun, Chiba pref 289-16). Its company brochure is enclosed in Appendix.

## **7.0 FUTURE PROSPECT OF FISHERY IN JAPAN**

The total quantity of fishing in Japan is expected to describe a downward curve at least for the coming five years, primary due to natural cyclical decrease of sardine resource in the sea area surrounding Japan. Japan's far sea fishing is also decreasing due to the 200 miles restriction and the decrease in number of younger fishermen.

In spite of an expected decrease in Japanese fisheries, fish consumption per capita is steadily increasing in Japan to reach 71 kg in 1992, which is the world's largest, compared to the world average of 13kg per capita per year. Such increased market demand in Japan is supported primary by the rapid increase of import of frozen fish, shrimps and other kinds of marine products. An increased attention is also paid to fish farming in Japan as a way to cope with the increased demand for fish products, and the production from farming of expensive fish is slowly increasing as a result.